

CHROMOSOME COUNTS IN THE GENUS *GAYOPHYTUM*<sup>1</sup>

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*Gayophytum*, an annual member of the family Onagraceae, consists of sixteen recognized taxa grouped into eight species. The genus, founded in 1832 by A. de Jussieu on a South American plant, *Gayophytum humile* Juss., is confined to narrow ecological niches along the cordillera of North and South America from Canada to Cape Horn, with an interval in Mexico and Central America where it has not been reported. It has not been found outside the mountain ranges of the western Americas.

As a genus, *Gayophytum* is very poorly known owing to the small size of the plants, the insignificant flowers (rarely as large as 5 mm. across), and the relative difficulty of obtaining specimens. The plants have linear-oblong leaves and very slender, diffusely branched stems. The ultimate branchlets are often filiform and bear numerous tiny four-petaled flowers in the upper axils. The bushy habit of the plants often with a great number of branching thread-like stems gives them a fuliginous aspect, and when in flower, the blossoms appear to be floating near the ground, hence the popular common name "Ground Smoke."

The flowers are perfect, actinomorphic and tetramerous. The sepals are in the orthogonal and the petals in the diagonal planes. Ovaries are bicellular and inferior, with ovules in one row in each loculus. The fruit is dry, splitting loculicidally and septifragally so the inner portion of the fertile carpels is left as a seed-bearing column in the center (Saunders 1940).

*Gayophytum* may be distinguished from the very similar *Epilobium* by the lack of coma on the seeds, by the two-celled ovaries and fruits, and by having solitary pollen grains.

Plants of *Oenothera* of similar size and habit and with equally reflexed sepals may be distinguished from *Gayophytum* by their more elongate hypanthium and four-celled ovary. The prevailing flower color of *Oenothera* is yellow; the flowers of *Gayophytum* are white, turning rose-purple with age.

In the words of Munz (1932): "The genus *Gayophytum* offers an unusually interesting series of plants varying in a comparatively small number of characters, and these in every conceivable combination. Flowers may be small or large; capsules may be sessile or pedicelled, erect or spreading-deflexed, short or long, torulose or not torulose; the minute hairs may be appressed or spreading; seeds may be glabrous or pubescent; branching may be basal or distinctly above the base. The attempt at classification . . . may be quite artificial; it has been arrived at only after

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TABLE 1. CHROMOSOME NUMBER AND SOURCE OF GAYOPHYTUM COLLECTIONS STUDIED

SPECIES	CHROMOSOME No. 2n	SOURCE
<i>G. Helleri</i> var. <i>glabrum</i> Munz	14	Washington, Douglas Co.: 6 mi. N. of Withrow, Route 10-B, on <i>Artemisia</i> knolls, <i>Dixon 9</i> .
<i>G. humile</i> Juss.	14	California, Mono Co.: Carnegie Inst. Timberline Station, Slate Creek Valley, 10,000 ft. elev. <i>H. Lewis</i> .
<i>G. lasiospermum</i> Greene	28	Idaho, Valley Co.: 1 mi. S. of Lake Fork, Route 15, on coarse gravel of ditches, <i>Dixon 14</i> .
<i>G. lasiospermum</i> Greene	28	Idaho, Adams Co.: 4.5 mi. S. of New Meadows, on cut-over <i>Pinus ponderosa</i> flat, W of Route 95, <i>Dixon 17</i> .
<i>G. Nuttallii</i> T. & G.	28	Washington, Okanogan Co.: 5 mi. W. of Republic Route 4, on moist clay and gravel road-cut, <i>Dixon 7</i> .
<i>G. Nuttallii</i> T. & G.	28	Idaho, Valley Co.: within city limits of McCall, on sand banks, <i>Dixon 12</i> .
<i>G. Nuttallii</i> T. & G.	28	Idaho, Latah Co.: on roadside sand of Saddle between Twin Buttes, Moscow Mountain, <i>Rumely &amp; Dixon</i> .
<i>G. Nuttallii</i> T. & G.	28	California, Tuolumne Co.: 4.4 mi. W. of Kennedy Meadows, Highway 108, Deadman Creek at 6,000 ft. elevation. <i>Balls &amp; Everett 18074</i> .
<i>G. Nuttallii</i> var. <i>Abramsii</i> Munz	28	Washington, Stevens Co.: 2 mi. S. of Kettle Falls, Route 22, fine sand in <i>Pinus</i> flat, <i>Dixon 3</i> .
<i>G. racemosum</i> var. <i>erosulatum</i> Munz	28	Idaho, Valley Co.: 1 mi. S. of Lake Fork, Route 15, on coarse gravel road-bank, <i>Dixon 15</i> .

much study. Unfortunately geographical distribution which is so often a great aid to the systematist, is not very useful here, and one almost doubts the validity of some of the entities maintained because of lack of continuous or definite distribution. Furthermore, the floral parts are so minute that individual specimens can easily be thrown into the wrong group. Yet, as I have worked over many hundreds of sheets at various times . . . , I have been forced to conclude that there are several very real and definite entities in the genus."

The taxonomic treatments of Trelease (1893) and Munz (1932, 1951, 1952) have proved satisfactory and have been followed in this study. Trelease expressed the opinion that *Gayophytum* may be of rather recent

differentiation from *Oenothera*, representing an accentuated montane-type.

A possible origin of *Epilobium* ( $n=18$ ) by the "addition" of eleven chromosomes of *Gayophytum ramosissimum* T.&G. ( $n=11$ ) to the seven of *Boisduvalia* ( $n=7$ ) has been suggested by Johansen (1933). This view that *Epilobium* may be of hybrid origin, however, has not been supported.

Very little is known about the cytology of *Gayophytum*. Johansen's (1933) work on *G. ramosissimum* is the only published report of previous cytological study in this genus. It was with the objective of adding to the cytological information on this genus that the present study was undertaken.

Plants for this study were collected during the late summer months of 1955 and 1956, in eastern Washington, central and southwestern Idaho, and northeastern Oregon. Additional seeds were supplied by Dr. Harlan Lewis and by Dr. P. A. Munz. Dr. Munz kindly identified the plants used.

Plants of *Gayophytum nuttallii* T.&G. were grown to maturity in the greenhouse, but no other species survived past the seedling stage in cultivation. Root-tips were the source of the meristematic tissues used in this study.

Field collected root-tips were fixed in Belling's metaphase modification of Navashin's fixative. Paraffin sections cut at ten microns were prepared and then stained by the crystal violet-iodine method (Johansen, 1940).

Chromosome numbers of  $2n=14$  and  $2n=28$  were found in the plants studied. Johansen (1933) lists the number  $2n=22$  for the North American species, *Gayophytum ramosissimum*. The number  $2n=28$  was found to be constant in collections of *Gayophytum lasiospermum* Greene, *G. Nuttallii*, *G. Nuttallii* var. *Abramsii* Munz, and *G. racemosum* var. *erosulatum* Munz. The number  $2n=14$  was discovered in *Gayophytum Helleri* var. *glabrum* Munz and in *G. humile*.

On moistened filter-paper in Petri dishes kept at room temperature, seeds of the 14-chromosome species had a relatively vigorous germination percentage of 11 per cent, whereas those of the 28-chromosome species under the same conditions may have as low as one-fourth of 1 per cent germination.

The two 14-chromosome species were collected at elevations of 2,000 and 10,000 feet, respectively. The 28-chromosome species are from elevations ranging from 900 feet to over 6,000 feet. The 14-chromosome species tend to be smaller in stature and have smaller flowers than those with 28 chromosomes, but marked phenotypic differences are not evident between the two groups.

#### DISCUSSION

It is suggested that the 14 chromosomes counted in *Gayophytum Helleri* var. *glabrum* and in *G. humile* may make up the basic diploid complement of the genus. If this is the case, it may be assumed that the species with 28 chromosomes constitute a number of tetraploid taxa. The chromo-

some do appear in reasonably recognizable sets of four in these species.

The chromosome numbers reported in this root-tip study are not consistent with the 22 chromosomes reported for *Gayophytum ramosissimum* (Johansen, 1933) in which embryo-sac meiosis was examined. The species previously studied was not available for examination in the current investigation. The possibility exists of an aneuploid series of chromosomes in *Gayophytum*. The count of 22 might be an instance of a hyperploidy ( $3x + 1$ ) constitution.

A brief survey of the chromosome numbers (Darlington and Wylie, 1956) in the family Onagraceae reveals a range of basic numbers occurring in *Clarkia* (including *Godetia*) ranging from  $x = 5$  through 7, 8, and 9; *Gaura* may have  $x = 7$  or 9. Other genera reported show  $x = 7$  constant for *Oenothera*,  $x = 8$  for *Jussieua*,  $x = 11$  for *Circaea*, *Lopezia*, and *Fuchsia*, with  $x = 15$  for *Zauschneria* and  $x = 18$  for *Epilobium*.

It is apparent that *Gayophytum* fits most closely into the chromosome series of the family near *Oenothera*. Such a position would agree with Trelease's view (1893) that *Gayophytum* may be of rather recent differentiation from *Oenothera*.

#### SUMMARY

Mitotic chromosome studies were made on ten collections of six taxa representing five species of *Gayophytum*. Chromosome numbers of  $2n = 14$  and 28 were found. The numbers 14 and 28 are in addition to the one of 22 previously reported for the genus.

Chromosome counts for *Gayophytum Helleri* var. *glabrum*, *G. humile*, *G. lasiospermum*, *G. Nuttallii*, *G. Nuttallii* var. *Abramsii*, and *G. racemosum* var. *erosulatum* are reported for the first time. Voucher specimens are on file in the herbarium of the State College of Washington.

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